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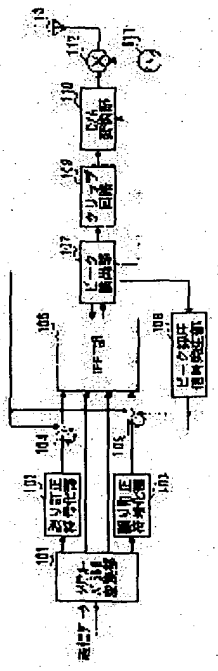
(54) UNIT AND METHOD FOR MULTI-CARRIER COMMUNICATION

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a multi-carrier communication unit that can suppress peak power while preventing reduction of transmission efficiency.
SOLUTION: A serial/parallel conversion section 101 converts transmission data of one sequence into transmission data of a plurality of sequences, outputs the transmission data of the 1st and 4th sequences respectively to error correction coding sections 102, 103 and outputs the transmission data of the 2nd and 3rd sequences to an IFFT(Inverse Fast Fourier Transform) section 106. The IFFT section 106 uses the transmission data of the 2nd and 3rd sequences and the transmission data of the 1st and 4th sequences after the error correction coding processing to generate an OFDM signal. A peak detection section 107 detects the peak power of the generated OFDM signal. When the detected peak power exceeds a threshold value, the IFFT section 106 reproduces the OFDM signal by using a peak suppression signal from a peak suppression signal generating section 108 in place of the transmission data of the 1st and 4th sequences.



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CLAIMS

[Claim(s)]

[Claim 1] The multi-carrier communication device characterized by providing the following. A conversion means to change the information signal of one sequence into the information signal of two or more sequences. A generation means to generate a multi-carrier signal by superimposing two or more each of the information signal of a sequence to a subcarrier peculiar to a sequence. A peak-power detection means to detect the peak power of the aforementioned multi-carrier signal. The regeneration means which carries out regeneration of the multi-carrier signal at the time of superimposing the signal for replacing with an information signal to the specific subcarrier of the aforementioned subcarriers, and oppressing a peak power when the aforementioned peak power exceeds a threshold, and the aforementioned peak power exceeding a threshold.

[Claim 2] It is the multi-carrier communication device according to claim 1 which a conversion means performs error correcting code-ized processing to the information signal of a predetermined sequence among the information signals of two or more sequences, and is characterized by a generation means superimposing the information signal of each sequence by which error correcting code-ized processing was made to a specific subcarrier peculiar to a sequence.

[Claim 3] A regeneration means is a multi-carrier communication device according to claim 1 characterized by using at least one subcarrier chosen from all subcarriers as a specific subcarrier.

[Claim 4] A regeneration means is a multi-carrier communication device given in either of a claim 1 to the claims 3 characterized by using a random signal as a signal for oppressing a peak power.

[Claim 5] A regeneration means is a multi-carrier communication device according to claim 4 which possesses a storage means to memorize the generation result of the multi-carrier signal calculated beforehand, and is characterized by carrying out regeneration of the multi-carrier signal using the memorized generation result as a signal for a regeneration means oppressing a peak power using the signal with which an amplitude and the phase were restricted.

[Claim 6] A regeneration means is a multi-carrier communication device given in either of a claim 1 to the claims 3 characterized by an amplitude using the signal of abbreviation 0 as a signal for oppressing a peak power.

[Claim 7] From the claim 1 characterized by providing a clipping means by which a peak power performs clipping processing to the multi-carrier signal exceeding a threshold among the multi-carrier signals generated by the generation means to a multi-carrier communication device according to claim 6

[Claim 8] The communication terminal characterized by equipping either of a claim 1 to the claims 7 with the multi-carrier communication device of a publication.

[Claim 9] Base station equipment characterized by equipping either of a claim 1 to the claims 7 with the multi-carrier communication device of a publication.

[Claim 10] The multi-carrier correspondence procedure characterized by providing the following. The conversion process which changes the information signal of one sequence into the information signal of two or more sequences. The generation process which generates a multi-carrier signal by superimposing two or more each of the information signal of a sequence to a subcarrier peculiar to a sequence. The peak-power detection process of detecting the peak power of the aforementioned multi-carrier signal. The regeneration process which carries out regeneration of the multi-carrier signal at the time of superimposing the signal for replacing with an information signal to the specific subcarrier of the aforementioned subcarriers, and oppressing a peak power when the aforementioned peak power exceeds a threshold, and the aforementioned peak power exceeding a threshold.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] Especially this invention relates to the communication device of the multi-carrier transmission system which oppresses a peak power about the communication device of a multi-carrier transmission system.
[0002]
[Description of the Prior Art] As a communication device of the multi-carrier transmission system which oppresses the conventional peak power, the thing of a publication is in Shingaku Giho RCS 99-144 (1999-11) "the peak-power suppression method using the parity carrier in multi-carrier transmission." Hereafter, the communication device of the above-mentioned conventional multi-carrier transmission system is explained.
[0003] In a multi-carrier transmission system, there is a fault that the peak power to mean power becomes large in proportion to the number of carriers. For this reason, since the influence of the nonlinear distortion in power amplifier becomes large, the spectrum radiation to the area outside an opposite will increase.
[0004] In order to solve such a problem, a compensatory signal which serves as a multi-carrier signal and an opposite phase at the time when the peak power exceeding a certain threshold appears is generated, this signal is arranged on the specific carrier (carrier with which the carrier for transmitting an information signal was formed independently) called compensation carrier (parity carrier), and a multi-carrier signal is generated. Thereby, the peak power of a multi-carrier signal can be oppressed.
[0005]
[Problem(s) to be Solved by the Invention] However, there are the following problems in the communication device of the above-mentioned conventional multi-carrier transmission system. That is, although it becomes possible to oppress the peak power of a multi-carrier signal by arranging a compensatory signal on a compensation carrier, the total of the carrier (henceforth an "information carrier") for only the part of this compensation carrier transmitting an information signal decreases. That is, although a compensation carrier is a carrier contributed to suppression of a peak power, it can be said to an information transmission as the carrier which is not contributed. Consequently, there is a problem that a transmission efficiency falls, in the communication device of the above-mentioned conventional multi-carrier transmission system.
[0006] It aims at offering the multi-carrier communication device which oppresses a peak power, this invention being made in view of this point, and suppressing decline in a transmission efficiency.
[0007]
[Means for Solving the Problem] A conversion means by which the multi-carrier communication device of this invention changes the information signal of one sequence into the information signal of two or more sequences, A generation means to generate a multi-carrier signal by superimposing two or more each of the information signal of a sequence to a subcarrier peculiar to a sequence, A peak-power detection means to detect the peak power of the aforementioned multi-carrier signal, and when the aforementioned peak power exceeds a threshold The signal for replacing with an information signal to the specific subcarrier of the aforementioned subcarriers, and oppressing a peak power is superimposed, and the composition possessing the regeneration means which carries out regeneration of the multi-carrier signal at the time of the aforementioned peak power exceeding a threshold is taken.
[0008] A peak power can be oppressed suppressing decline in a transmission efficiency by superimposing the signal for replacing with an information signal and oppressing a peak power to the specific subcarrier of all the subcarriers, when according to this composition an information signal is superimposed to all subcarriers when a peak power does not occur to a multi-carrier signal, and a peak power occurs to a multi-carrier signal.
[0009] Error correcting code-ized processing is performed to the information signal of a sequence predetermined

[communication device / multi-carrier / of this invention / among the information signals of two or more sequences] in a conversion means, and a generation means takes the composition on which the information signal of each sequence by which error correcting code-ized processing was made is superimposed to a specific subcarrier peculiar to a sequence.

[0010] Even if the information signal of a predetermined sequence is superimposed on the signal for replacing with an information signal and oppressing a peak power to the subcarrier which transmits the information signal of the above-mentioned sequence by performing error correcting code-ized processing according to this composition, the information signal of the above-mentioned sequence is received in good quality by making error correction decryption processing in a receiving set.

[0011] The multi-carrier communication device of this invention takes the composition using at least one subcarrier which the regeneration means chose from all subcarriers as a specific subcarrier.

[0012] While being able to oppress the peak power in a multi-carrier signal certainly by stopping transmission of the information signal by the specific subcarrier in a peak suppression state according to this composition, in a normal state, decline in a transmission efficiency can be suppressed by superimposing an information signal on all subcarriers.

[0013] The multi-carrier communication device of this invention takes the composition using a signal with a regeneration means random as a signal for oppressing a peak power.

[0014] Since the signal amplitude of a multi-carrier signal can be made small by using a random signal as a signal for oppressing a peak power according to this composition, a peak power can carry out regeneration of the repressed multi-carrier signal.

[0015] The multi-carrier communication device of this invention possesses a storage means by which a regeneration means memorizes the generation result of the multi-carrier signal calculated beforehand using the signal with which an amplitude and the phase were restricted as a signal for a regeneration means oppressing a peak power, and the composition which carries out regeneration of the multi-carrier signal using the memorized generation result is taken.

[0016] If there are few total subcarriers according to this composition, it will become possible to calculate the IFFT result of an operation off-line beforehand, and to memorize this result of an operation. Since the multi-carrier signal generated can be uniquely acquired by this according to the signal on which a subcarrier is overlapped, the amount of operations at the time of generating a multi-carrier signal can be decreased.

[0017] The multi-carrier communication device of this invention takes composition of an amplitude using the signal of abbreviation 0 as a signal for a regeneration means oppressing a peak power.

[0018] Since the signal amplitude of a multi-carrier signal can be made small by preparing the subcarrier which does not transmit an information signal according to this composition, a peak power can carry out regeneration of the repressed multi-carrier signal.

[0019] The multi-carrier communication device of this invention takes the composition possessing a clipping means to perform clipping processing, among the multi-carrier signals generated by the generation means to the multi-carrier signal with which a peak power exceeds a threshold.

[0020] Since the peak power of the multi-carrier signal generated first can be stopped by clipping processing when the peak power of the multi-carrier signal by which regeneration was carried out by superimposing the signal for oppressing a peak power on a specific subcarrier cannot be oppressed below to a threshold according to this composition, influence of the nonlinear distortion in power amplifier can be made small.

[0021] The communication terminal of this invention takes the composition equipped with the multi-carrier communication device of one of the above.

[0022] According to this composition, suppressing decline in a transmission efficiency, by carrying the multi-carrier communication device which oppresses a peak power, influence of the nonlinear distortion in power amplifier can be made small, and the spectrum radiation to the area outside an opposite can be suppressed.

[0023] The base station equipment of this invention takes the composition equipped with the multi-carrier communication device of one of the above.

[0024] According to this composition, suppressing decline in a transmission efficiency, by carrying the multi-carrier communication device which oppresses a peak power, influence of the nonlinear distortion in power amplifier can be made small, and the spectrum radiation to the area outside an opposite can be suppressed.

[0025] The conversion process from which the multi-carrier correspondence procedure of this invention changes the information signal of one sequence into the information signal of two or more sequences, The generation process which generates a multi-carrier signal by superimposing two or more each of the information signal of a sequence to a subcarrier peculiar to a sequence, The peak-power detection process of detecting the peak power of the aforementioned multi-carrier signal, and when the aforementioned peak power exceeds a threshold The signal for replacing with an information signal to the specific subcarrier of the aforementioned subcarriers, and oppressing a peak power is

superimposed, and the regeneration process which carries out regeneration of the multi-carrier signal at the time of the aforementioned peak power exceeding a threshold was provided.

[0026] A peak power can be oppressed suppressing decline in a transmission efficiency by superimposing the signal for replacing with an information signal and oppressing a peak power to the specific subcarrier of all the subcarriers, when according to this method an information signal is superimposed to all subcarriers when a peak power does not occur to a multi-carrier signal, and a peak power occurs to a multi-carrier signal.

[0027]

[Embodiments of the Invention] The subcarrier for this invention persons transmitting only the signal which oppresses a peak power [when the peak power which exceeds a threshold to a multi-carrier signal has not occurred] it being alike and noting that it is possible to use as a subcarrier for transmitting an information signal, and, when the peak power which exceeds a threshold to a multi-carrier signal does not occur By using all subcarriers for transmission of an information signal, a bird clapper is found out as it is possible to suppress decline in a transmission efficiency, and it came to carry out this invention.

[0028] The main point of this invention is having superimposed the signal for replacing with an information signal and oppressing a peak power to the specific subcarrier of all the subcarriers, when an information signal is superimposed to all subcarriers when a peak power does not occur to a multi-carrier signal, and a peak power occurs to a multi-carrier signal.

[0029] Hereafter, the gestalt of operation of this invention is explained in detail with reference to a drawing. In addition, in the gestalt of the following operations, the number of subcarriers to be used is explained taking the case of the case where it is referred to as 4.

[0030] (Gestalt 1 of operation) The gestalt of this operation prepares the subcarrier which transmits both a peak suppression signal and an information signal, and the subcarrier which transmits only an information signal rather than prepares the subcarrier which transmits only a peak suppression signal fixed, and the subcarrier which transmits only an information signal.

[0031] Drawing 1 is the block diagram showing the composition of the sending set equipped with the multi-carrier communication device concerning the gestalt 1 of operation of this invention. In drawing 1 , the serial-parallel (henceforth "S/P") transducer 101 changes the transmit data of one sequence into the transmit data of two or more sequences (here, it considers as four sequences as an example.). In addition, the number of sequences here is equivalent to the total number of subcarriers. Here, the transmit data of the 1st sequence - the 4th sequence is called for convenience, applying [of two or more sequences shown in drawing 1] it to the lower part from the upper part.

[0032] The S/P transducer 101 sends the transmit data of a standard rate to the reverse fast-Fourier-transform (it is called "IFFT" below Inverse Fast Fourier Transform;.) section 106 as the transmit data of the 2nd sequence, and transmit data of the 3rd sequence. Moreover, the S/P transducer 101 sends the transmit data of a low rate to the error correcting code-ized section 102 and the error correcting code-ized section 103 as the transmit data of the 1st sequence, and transmit data of the 4th sequence, respectively.

[0033] The error correcting code-ized section 102 and the error correcting code-ized section 103 perform predetermined error correcting code-ized processing to the transmit data of the 1st sequence, and the transmit data of the 4th sequence, respectively, and send the transmit data after error correcting code-ized processing to a switch 104 and a switch 105, respectively.

[0034] The peak suppression signal generator 108 generates the peak suppression signal over a switch 104 and a switch 105 based on the detection result in the peak-detection section 107 mentioned later. In addition, about the detail of a peak suppression signal, it mentions later.

[0035] A switch 104 outputs the peak suppression signal from the transmit data or the peak suppression signal generator 108 of the 1st sequence from the error correcting code-ized section 102 to the IFFT section 106 in response to control by the peak-detection section 107 mentioned later. Moreover, a switch 105 outputs the peak suppression signal from the transmit data or the peak suppression signal generator 108 of the 4th sequence from the error correcting code-ized section 103 to the IFFT section 106 in response to control by the peak-detection section 107 mentioned later.

[0036] The IFFT section 106 performs Frequency-Division-Multiplexing processing by performing IFFT (reverse fast Fourier transform) processing per symbol in response to the control of the peak-detection section 107 mentioned later using the transmit data of the 2nd sequence, the transmit data of the 3rd sequence, and two peak suppression signals, using the transmit data of the transmit data of the 1st sequence - the 4th sequence.

[0037] The IFFT section 106 generates the OFDM signal (multi-carrier signal) with which it was superimposed on the OFDM signal (multi-carrier signal) with which this Frequency-Division-Multiplexing processing was overlapped in the transmit data of the transmit data of the 1st sequence - the 4th sequence on the subcarrier or the transmit data of the

2nd sequence, the transmit data of the 3rd sequence, and two peak suppression signals at the subcarrier per symbol, and the OFDM signal of the generated symbol unit is sent to the peak-detection section 107. In order to simplify explanation here, the subcarrier superimposed on the transmit data or the peak suppression signal of the 1st sequence is made into "the 1st subcarrier", and the subcarrier superimposed on the transmit data of the 2nd sequence is made into "the 2nd subcarrier", and the subcarrier superimposed on the transmit data of the 3rd sequence is made into "the 3rd subcarrier", and let the subcarrier superimposed on the transmit data or the peak suppression signal of the 4th sequence be "the 4th subcarrier."

[0038] The peak-detection section 107 measures the power of the OFDM signal from the IFFT section 106 per symbol, and detects whether the peak power exceeding a threshold has occurred about the OFDM signal in each symbol. The peak-detection section 107 sends the OFDM signal in the symbol which this peak power has not generated to the D/A-conversion section 110, when the peak power which exceeds a threshold to an OFDM signal has not occurred.

[0039] Moreover, the peak-detection section 107 controls the IFFT section 106, the peak suppression signal generator 108, a switch 104, and a switch 105 as follows while memorizing temporarily the OFDM signal in the symbol which generated this peak power, when the peak power which exceeds a threshold to an OFDM signal occurs.

[0040] That is, the peak-detection section 107 controls the IFFT section 106 first to perform regeneration of the OFDM signal in the symbol which generated the peak power exceeding a threshold. Furthermore, the peak-detection section 107 is controlled to generate a peak suppression signal to the peak suppression signal generator 108.

[0041] Moreover, the peak-detection section 107 controls a switch 105 to replace with the transmit data of the 4th sequence from the error correcting code-ized section 103, and to output the peak suppression signal from the peak suppression signal generator 108 to the IFFT section 106 while controlling a switch 104 to replace with the transmit data of the 1st sequence from the error correcting code-ized section 102, and to output the peak suppression signal from the peak suppression signal generator 108 to the IFFT section 106.

[0042] Thereby, the IFFT section 106 can carry out regeneration of the OFDM signal in the symbol which generated the peak power which exceeds a threshold in the peak-detection section 107 using the transmit data of the 2nd sequence, the transmit data of the 3rd sequence, and two peak suppression signals. In addition, the transmit data of the 2nd sequence of the above used by the IFFT section 106 and the transmit data of the 3rd sequence are the same as that of the transmit data of the 2nd sequence in the symbol which generated the peak power, respectively, and the transmit data of the 3rd sequence.

[0043] Moreover, the peak-detection section 107 controls the IFFT section 106 to continue regeneration of the OFDM signal in the symbol which generated the peak power while generating a peak suppression signal to the peak suppression signal generator 108 until the number of the 1st repeats reaches the number of conventions when the peak power which still exceeds a threshold also to the OFDM signal in which regeneration was carried out by the IFFT section 106 has occurred. The peak-detection section 107 sends the OFDM signal in the symbol concerned held temporarily to a clipping circuit 109, when the number of the 1st repeats reaches the number of conventions at this time.

[0044] A clipping circuit 109 performs clipping processing to the OFDM signal from the peak-detection section 107, and sends the OFDM signal after clipping processing to the D/A-conversion section 110.

[0045] The D/A-conversion section 110 changes an OFDM signal into an analog signal by performing D/A-conversion processing to the peak-detection section 107 or the OFDM signal from a clipping circuit 109.

[0046] The multiplication section 112 performs modulation processing to the OFDM signal changed into the analog signal by carrying out the multiplication of the OFDM signal and the local signal from VCO 111 which were changed into the analog signal. The OFDM signal after modulation processing is transmitted to a communications partner through an antenna 113.

[0047] Drawing 2 is the block diagram showing the composition of the sending set equipped with the multi-carrier communication device concerning the gestalt 1 of operation of this invention, and the receiving set which performs radio. The signal transmitted by the communications partner is received by the antenna 201 in drawing 2 . In addition, the above-mentioned communications partner possesses the composition shown in drawing 1 .

[0048] The multiplication section 203 generates a recovery signal by carrying out the multiplication of the signal (input signal) and the local signal from VCO 202 which were received by the antenna 201. The A/D-conversion section 204 changes a recovery signal into a digital signal by performing A/D-conversion processing to the recovery signal from the multiplication section 203.

[0049] The fast-Fourier-transform (it is called "FFT" below Fast Fourier Transform;.) section 205 extracts the signal transmitted by each subcarrier (namely, the 1st subcarrier - the 4th subcarrier) by performing FFT (fast Fourier transform) processing to the recovery signal changed into the digital signal. Here, in order to simplify explanation, the signal transmitted by the 1st subcarrier - the 4th subcarrier is made into "1st recovery signal" - "the 4th recovery

signal", respectively.
[0050] this FFT section 205 -- the [the 1st recovery signal and] -- 4 recovery signals -- respectively -- the error correction decode section 206 and the error correction decode section 207 -- sending -- the [the 2nd recovery signal and] -- 3 recovery signals are sent to the parallel-serial (henceforth "P/S") transducer 208
[0051] The error correction decode section 206 performs error correction decode processing to the 1st recovery signal, and sends the 1st recovery signal after error correction decode processing to the P/S transducer 208. The error correction decode section 207 performs error correction decode processing to the 4th recovery signal, and sends the 4th recovery signal after error correction decode processing to the P/S transducer 208. In addition, error correction decode processing in which it is used by the error correction decode section 206 and the error correction decode section 207 is equivalent to error correcting code-ized processing in which it was used by the communications partner.
[0052] The P/S transducer 208 changes the recovery signal (namely, the [the 1st recovery signal after error correction decode processing, and] the [4 recovery signals, the 2nd recovery signal, and] 3 recovery signals) of two or more sequences into the decode data of one sequence.
[0053] Subsequently, operation of the sending set equipped with the multi-carrier communication device concerning the gestalt of this operation and operation of this sending set and the receiving set which performs radio are explained with reference to drawing 3 (a) and drawing 3 (b) with drawing 1 and drawing 2 . Drawing 3 (a) and drawing 3 (b) are the ** type views showing an example of the situation of the transmit data inputted into the IFFT section 106 in the sending set equipped with the multi-carrier communication device concerning the gestalt 1 of operation of this invention.
[0054] The transmit data of one sequence is changed into the transmit data of the 1st sequence - the 4th sequence by the S/P transducer 101 in drawing 1 . The transmit data of the 2nd sequence and the transmit data of the 3rd sequence are sent to the IFFT section 106, the information transmission rate being used as a standard rate. The transmit data of the 1st sequence and the transmit data of the 4th sequence are sent to the error correcting code-ized section 102 and the error correcting code-ized section 103, respectively, the information transmission rate being used as a low rate. Here, let the transmit data of the 1st sequence, and the transmit data of the 4th sequence be low rates for making it the rate after error correcting code-ized processing of the transmit data of the 1st sequence and the transmit data of the 4th sequence become equal to the rate of the transmit data of the 2nd sequence, and the transmit data of the 3rd sequence compared with the transmit data of the 2nd sequence, and the transmit data of the 3rd sequence.
[0055] As for the transmit data of the 1st sequence, and the transmit data of the 4th sequence, predetermined error correcting code-ized processing is made by the error correcting code-ized section 102 and the error correcting code-ized section 103, respectively. It is also possible to use the error correcting code-ized processing using block codes (a Hamming code, a BCH code, a Reed Solomon code, fire code, etc.) as the above-mentioned predetermined error correcting code-ized processing here, and it is also possible to use the error correcting code-ized processing using convolutional codes (a turbo sign, a self-orthogonal code, a HAGERU hamburger sign, the Iwadare sign, etc.).
[0056] The transmit data of the 1st sequence by which error correcting code-ized processing was made by the error correcting code-ized section 102 and the error correcting code-ized section 103, and the transmit data of the 4th sequence are sent to a switch 104 and a switch 105, respectively. In addition, the rate of the transmit data of the 1st sequence by which error correcting code-ized processing was made, and the transmit data of the 4th sequence is equal to the rate of the transmit data of the 2nd sequence, and the transmit data of the 3rd sequence by this error correction processing.
[0057] When this equipment is in a normal state (when the peak power which exceeds a threshold to the OFDM signal generated by the IFFT section 106 is not detected by the peak-detection section 107), a switch 104 and a switch 105 are controlled by the peak-detection section 107 to output the transmit data of the 1st sequence from the error correcting code-ized section 102, and the transmit data of the 4th sequence from the error correcting code-ized section 103 to the IFFT section 106, respectively. Thereby, the transmit data of the 1st sequence - the 4th sequence is inputted into the IFFT section 106. All the transmit data of the 1st sequence - the 4th sequence inputted into the IFFT section 106 serve as the same rate (refer to drawing 3 (a)).
[0058] In the IFFT section 106, IFFT processing (namely, Frequency-Division-Multiplexing processing) using the transmit data of the 1st sequence - the 4th sequence is performed. The OFDM signal with which the 1st subcarrier - the 4th subcarrier were overlapped on the transmit data of the 1st sequence - the 4th sequence, respectively is generated by this Frequency-Division-Multiplexing processing. The generated OFDM signal is sent to the peak-detection section 107.
[0059] In the peak-detection section 107, it is detected whether the peak power to which the power of the OFDM signal from the IFFT section 106 is measured per symbol, and exceeds a threshold to the OFDM signal in each symbol has occurred.

[0060] When the peak power which exceeds a threshold from the IFFT section 106 to an OFDM signal has not occurred, the OFDM signal in the symbol which this peak power has not generated is sent to the D/A-conversion section 110.

[0061] On the contrary, when the peak power which exceeds a threshold from the IFFT section 106 to an OFDM signal occurs, while the OFDM signal in the symbol which generated this peak power is memorized temporarily, this equipment shifts to a peak suppression state from a normal state. For example, when the peak power which exceeds a threshold to the OFDM signal in a symbol 301 occurs with reference to drawing 3 (a), while the OFDM signal in this symbol 301 is memorized temporarily, this equipment shifts to a peak suppression state from a normal state. In addition, the OFDM signal in a symbol 301 is a signal generated by the IFFT processing which used the signal "S1" - the signal "S4" as a signal of the 1st sequence - the 4th sequence, respectively.

[0062] The following processings are made when this equipment shifts to a peak suppression state. That is, the control signal of the purport which performs regeneration of the OFDM signal in the symbol which generated the peak power which exceeds a threshold from the peak-detection section 107 to the IFFT section 106 is sent. Furthermore, the control signal of the purport which outputs a peak suppression signal to a switch 104 and a switch 105 from the peak-detection section 107 to the peak suppression signal generator 108 is sent. Moreover, while the control signal of the purport which replaces with the transmit data of the 1st sequence from the error correcting code-ized section 102 from the peak-detection section 107 to a switch 104, and outputs the peak suppression signal from the peak suppression signal generator 108 to the IFFT section 106 is sent The control signal of the purport which replaces with the transmit data of the 4th sequence from the error correcting code-ized section 103 from the peak-detection section 107 to a switch 105, and outputs the peak suppression signal from the peak suppression signal generator 108 to the IFFT section 106 is sent.

[0063] In the peak suppression signal generator 108 which received the above-mentioned control signal from the peak-detection section 107, generating of a peak suppression signal to a switch 104 and a switch 105 is performed.

[0064] Here, the peak suppression signal generated by the peak-detection section 107 is as follows. That is, a signal suitable (it is random) as a signal which replaces the transmit data of the 1st sequence and the 4th sequence is generated. In addition, it is good also as a signal which is good for mutual also as the same signal, and is mutually different in the peak suppression signal outputted to a switch 104 and a switch 105. However, this suitable signal is chosen according to the circuit scale of the IFFT section 106 from the signals with which the signal with which ** amplitude and the phase are not restricted, the signal with which ** amplitude was restricted, the signal with which ** phase was restricted, ** amplitude, and the phase were restricted.

[0065] If there are few total subcarriers when ** is especially used as a peak suppression signal (namely, when signals, such as a QPSK method with which an amplitude and the phase are restricted, are used), the IFFT result of an operation will be calculated off-line beforehand, and it will become possible to memorize this result of an operation as a look-up table. Consequently, according to the signal inputted into the IFFT section 106, the IFFT result of an operation is uniquely obtained by using this look-up table. Thereby, while being able to decrease the amount of operations in the IFFT section 106, the circuit scale of the IFFT section 106 can be made small.

[0066] Furthermore, since the signal to the IFFT section 106 inputted will be limited when ** or ** is used as a peak suppression signal, it is possible to simplify the computing element which performs an IFFT operation, and it is also possible to calculate the IFFT result of an operation off-line beforehand. Thereby, the circuit scale of the IFFT section can be made small.

[0067] With the gestalt of this operation, an OFDM signal is generated using a signal suitable (it is random) as a peak suppression signal, and when the peak power which exceeds a threshold to the generated OFDM signal has still occurred, the procedure of generating an OFDM signal using a suitable (it being random) signal different from the above as a peak suppression signal again is taken.

[0068] Consequently, with the transmit data of the 2nd sequence and the 3rd sequence, it will replace with the transmit data of the 1st sequence and the 4th sequence, and a peak suppression signal will be inputted into the IFFT section 106. in order [for example,] to carry out regeneration of the OFDM signal in the symbol 301 mentioned above with reference to drawing 3 (b) -- the IFFT section 106 -- a signal "S2" -- it reaches, and with a signal "S3", it replaces with a signal "S1" and a signal "S4", and a peak suppression signal "P1" and a peak suppression signal "P2" are inputted, respectively In addition, a signal "S2" and a signal "S3" are the same as the signal "S2" and signal "S3" which were inputted into the IFFT section 106 at the time of the normal state mentioned above, respectively (drawing 3 (a)).

[0069] In the IFFT section 106, it is recognized that this equipment shifted to the peak suppression state with the control signal from the peak-detection section 107. Consequently, in the IFFT section 106, regeneration of the OFDM signal in the symbol (symbol 301) which generated the peak power which exceeds a threshold in the peak-detection section 107 is carried out. That is, the OFDM signal with which the 1st subcarrier and the 4th subcarrier were

overlapped on the peak suppression signal, and the 2nd subcarrier and the 3rd subcarrier were overlapped on the transmit data of the 2nd sequence and the 3rd sequence, respectively is generated. For example, with reference to drawing 3 (b), the OFDM signal with which the 1st subcarrier and the 4th subcarrier were overlapped on the peak suppression signal "P1" and the peak suppression signal "P2", respectively, and the 2nd subcarrier and the 3rd subcarrier were overlapped on the signal "S2" and the signal "S3", respectively is generated.

[0070] Here, since the peak suppression signal inputted into the IFFT section 106 is a suitable (it is random) signal, it is a signal which may oppress the peak power of the OFDM signal generated by the IFFT section 106. Therefore, as for the OFDM signal in which regeneration was carried out by the IFFT section 106, a peak power may become a repressed thing.

[0071] Detection of whether by the peak-detection section 107, as mentioned above, the peak power exceeding a threshold has generated the OFDM signal in which regeneration was carried out by the IFFT section 106 is made. When the peak power which exceeds a threshold to the OFDM signal by which regeneration was carried out has not occurred, this OFDM signal by which regeneration was carried out is sent to the D/A-conversion section 110.

[0072] On the contrary, when the peak power which still exceeds a threshold to the OFDM signal by which regeneration was carried out has occurred, the control signal of the purport which performs regeneration of the OFDM signal in the symbol concerned from the peak-detection section 107 to the IFFT section 106 is sent, and the control signal of the purport which outputs a peak suppression signal to a switch 104 and a switch 105 from the peak-detection section 107 to the peak suppression signal generator 108 is sent again. At this time, the number of the 1st repeats about the regeneration of an OFDM signal is increased in the peak-detection section 107.

[0073] In the peak suppression signal generator 108 which received this control signal, generating of a peak suppression signal to a switch 104 and a switch 105 is performed again. However, a suitable signal other than the suitable signal mentioned above as a peak suppression signal again is generated at this time.

[0074] Consequently, in the IFFT section 106, using a new peak suppression signal, regeneration of the OFDM signal in the symbol which generated the peak power which exceeds a threshold in the peak-detection section 107 is carried out, and as the OFDM signal by which regeneration was carried out was mentioned above, detection of whether the peak power exceeding a threshold has occurred by the peak-detection section 107 is made.

[0075] Henceforth, while a peak suppression signal is updated by another, suitable signal until the peak power which exceeds a threshold to the OFDM signal by which regeneration was carried out stops occurring, the regeneration of the OFDM signal in the same symbol which was mentioned above is repeated. However, when the number of the 1st repeats reaches the number of conventions, the OFDM signal temporarily memorized by the peak-detection section 107 is sent to a clipping circuit 109.

[0076] As for this OFDM signal memorized temporarily, clipping processing is made by the clipping circuit 109. The method which cuts the power more than the threshold in an OFDM signal as clipping processing in a clipping circuit 109, the method which makes power of this OFDM signal below a threshold by lowering the overall level of an OFDM signal can be used.

[0077] The OFDM signal with which clipping processing was made is sent to the D/A-conversion section 110. Consequently, this equipment shifts to a normal state from a peak suppression state.

[0078] In the D/A-conversion section 110, the peak-detection section 107 or the OFDM signal from a clipping circuit 109 is changed into an analog signal by making D/A-conversion processing. Modulation processing is made by carrying out the multiplication of the OFDM signal changed into the analog signal to the local signal from VCO 111 in the multiplication section 112. The OFDM signal after modulation processing is transmitted to the receiving set shown in drawing 2 through an antenna 113.

[0079] In drawing 2 , the signal transmitted by the sending set equipped with the multi-carrier communication device concerning the gestalt of this operation is received by the antenna 201. A recovery signal is generated by carrying out the multiplication of the signal (input signal) received by the antenna 201 to the local signal from VCO 202 in the multiplication section 203. The generated recovery signal is changed into a digital signal by making A/D-conversion processing in the A/D-conversion section 204.

[0080] Each signal with which the recovery signal changed into the digital signal was transmitted by the 1st subcarrier - the 4th subcarrier by making FFT processing in the FFT section 205 is extracted. That is, in the FFT section 205, the 1st recovery signal - 4th recovery signal is extracted. In the gestalt of this operation, the extracted 1st recovery signal - the 4th recovery signal are equivalent to the signal on which the 1st subcarrier shown in drawing 3 (b) - the 4th subcarrier were overlapped, respectively.

[0081] the [the 1st recovery signal and] -- 4 recovery signals become what included the peak suppression signal in the OFDM signal in the symbol which the peak power exceeding a threshold generated for example, drawing 3 (b) -- referring to -- the [the 1st recovery signal and] -- 4 recovery signals include the usual not an information signal but

peak suppression signal in the symbol 301 This peak suppression signal serves as an unnecessary disturbance signal component for this receiving set. the [for this reason, / the 1st recovery signal and] -- 4 recovery signals may turn into a signal containing the error with this

[0082] the [then, / the 1st recovery signal and] -- 4 recovery signals are sent to the error correction decode section 206 and the error correction decode section 207, respectively the [moreover, / the 2nd recovery signal and] -- both 3 recovery signals are sent to the P/S transducer 208

[0083] the [the 1st recovery signal and] -- as for 4 recovery signals, error correction decode processing is made by the error correction decode section 206 and the error correcting code-ized section 207, respectively thereby -- the [the 1st recovery signal and] -- a suitable signal corrects the portion corresponding to the peak suppression signal in 4 recovery signals For example, with reference to drawing 3 (a) and drawing 3 (b), error correction processing corrects the signal "P1" and signal "P2" in the 1st recovery signal at the information signal before the error correcting code-ized processing in a sending set, respectively. the [the 1st recovery signal after error correction processing, and] -- 4 recovery signals are sent to the P/S transducer 208

[0084] the P/S transducer 208 -- setting -- the [the 2nd recovery signal and] -- 3 recovery signals and a row -- the [the 1st recovery signal after error correction decode processing, and] -- 4 recovery signals are changed into the decode data of one sequence The above is operation of the sending set equipped with the multi-carrier communication device concerning the gestalt of this operation, and operation of this sending set and the receiving set which performs radio.

[0085] Thus, in the gestalt of this operation, the subcarrier which transmits only a peak suppression signal fixed, and the subcarrier which transmits only an information signal were not prepared, but the subcarrier for compensation which transmits both a peak suppression signal and an information signal, and the subcarrier for information which transmits only an information signal are prepared.

[0086] Furthermore, in a normal state, to the subcarrier for information, it is usually superimposed on the information signal of a rate, and is superimposed on the signal with which error correcting code-ized processing was usually performed to the information signal of a low rate from the rate to the subcarrier for compensation. On the other hand, in a peak suppression state, to the subcarrier for compensation, it is superimposed on a peak suppression signal, and is superimposed on an information signal like a normal state to the subcarrier for information.

[0087] While being able to oppress the peak power in an OFDM signal certainly by superimposing a peak suppression signal on the subcarrier for compensation in a peak suppression state according to such composition, in a normal state, decline in a transmission efficiency can be suppressed by superimposing an information signal on all subcarriers (the subcarrier for information, and subcarrier for compensation).

[0088] Furthermore, as for the information signal on which this subcarrier for compensation is overlapped, error correcting code-ized processing is performed although the signal transmitted by the subcarrier for compensation will include not an information signal but a peak suppression signal (namely, mistaken signal) at the time of peak suppression. Thereby, the signal transmitted by this carrier for compensation turns into a signal which corrected the mistaken portion (portion of a peak suppression signal) by performing error correction decryption processing with receiving-side equipment. That is, the information signal on which the subcarrier for compensation is overlapped is received by receiving-side equipment in the good state.

[0089] As mentioned above, according to the gestalt of this operation, the multi-carrier communication device which oppresses a peak power can be offered, suppressing decline in a transmission efficiency.

[0090] In addition, in the gestalt of this operation, although the number of subcarriers to be used was explained taking the case of the case where it is referred to as 4, there is no limitation in the number of subcarriers to be used. Moreover, in the gestalt of this operation, although explained taking the case of the case where two subcarriers for compensation (the gestalt of this operation the 1st subcarrier and the 4th subcarrier) superimposed on an information signal and a peak suppression signal are used, it is possible to change the number of the subcarriers for compensation according to various conditions, such as peak-power suppression condition by the peak suppression signal.

[0091] (Gestalt 2 of operation) The gestalt of this operation prepares only the subcarrier for transmitting an information signal rather than prepares the subcarrier which transmits only a peak suppression signal fixed, and the subcarrier which transmits only an information signal, and when the peak power which exceeds a threshold to an OFDM signal generates the subcarrier of a predetermined number among this subcarrier, it is used for it as a subcarrier which stops transmission of an information signal.

[0092] The sending set hereafter equipped with the multi-carrier communication device concerning the gestalt of this operation is explained with reference to drawing 4 . Drawing 4 is the block diagram showing the composition of the sending set equipped with the multi-carrier communication device concerning the gestalt 2 of operation of this invention. In addition, about the same composition as the gestalt 1 (drawing 1) of the operation in drawing 4 , the same sign as the thing in drawing 1 is attached, and detailed explanation is omitted.

[0093] In drawing 4 , like the peak-detection section 107 in the gestalt 1 of operation, the peak-detection section 401 measures the power of the OFDM signal from the IFFT section 106 per symbol, and detects whether the peak power exceeding a threshold has occurred about the OFDM signal in each symbol. This peak-detection section 401 is different from the peak-detection section 107 in the gestalt 1 of operation in the following points.
[0094] That is, the peak-detection section 401 memorizes temporarily the OFDM signal in the symbol which generated this peak power when the peak power which exceeds a threshold to an OFDM signal occurred, notifies the purport which the peak power exceeding a threshold generated to the transmitting halt section 402, and controls the IFFT section 106 to perform regeneration of the OFDM signal in the symbol which generated the peak power exceeding a threshold.
[0095] The transmitting halt section 402 controls a switch 105 to suspend the output of the transmit data of the 4th sequence from the error correcting code-ized section 103 to the IFFT section 106 while controlling a switch 104 to suspend the output of the transmit data of the 1st sequence from the error correcting code-ized section 102 to the IFFT section 106, when it has been recognized that the peak power which exceeds a threshold to an OFDM signal by the notice from the peak-detection section 401 occurred.
[0096] Moreover, the peak-detection section 401 sends the OFDM signal in the symbol concerned held temporarily to a clipping circuit 109, when the peak power which still exceeds a threshold to the OFDM signal in which regeneration was carried out by the IFFT section 106 has occurred.
[0097] About the composition of the sending set equipped with the multi-carrier communication device concerning the gestalt of this operation on the other hand, and the receiving set which performs radio, since it is the same as that of what was explained with the gestalt 1 (drawing 2) of operation, detailed explanation is omitted.
[0098] Subsequently, operation of the sending set equipped with the multi-carrier communication device concerning the gestalt of this operation is again explained with reference to drawing 4 . When this equipment is in a normal state, a switch 104 and a switch 105 are controlled by the transmitting halt section 402 to output the transmit data of the 1st sequence from the error correcting code-ized section 102, and the transmit data of the 4th sequence from the error correcting code-ized section 103 to the IFFT section, respectively.
[0099] In the IFFT section 106, IFFT processing (namely, Frequency-Division-Multiplexing processing) using the transmit data of the 1st sequence - the 4th sequence is performed. The OFDM signal with which the 1st subcarrier - the 4th subcarrier were overlapped on the transmit data of the 1st sequence - the 4th sequence, respectively is generated by this Frequency-Division-Multiplexing processing. The generated OFDM signal is sent to the peak-detection section 401.
[0100] In the peak-detection section 401, it is detected whether the peak power to which the power of the OFDM signal from the IFFT section 106 is measured per symbol, and exceeds a threshold to the OFDM signal in each symbol has occurred.
[0101] When the peak power which exceeds a threshold from the IFFT section 106 to an OFDM signal has not occurred, the OFDM signal in the symbol which this peak power has not generated is sent to the D/A-conversion section 110.
[0102] On the contrary, when the peak power which exceeds a threshold from the IFFT section 106 to an OFDM signal occurs, while the OFDM signal in the symbol which generated this peak power is memorized temporarily, this equipment shifts to a peak suppression state from a normal state.
[0103] The following processings are made when this equipment shifts to a peak suppression state. That is, the control signal of the purport which performs regeneration of the OFDM signal in the symbol which generated the peak power which exceeds a threshold from the peak-detection section 401 to the IFFT section 106 is sent.
[0104] Furthermore, the purport which the peak power which exceeds a threshold from the peak-detection section 401 to an OFDM signal to the transmitting halt section 402 generated is notified. Thereby, a switch 104 is controlled by the transmitting halt section 402 to suspend the output of the transmit data of the 1st sequence to the IFFT section 106 from the error correcting code-ized section 102. Similarly, a switch 105 is controlled by the transmitting halt section 402 to suspend the output of the transmit data of the 4th sequence to the IFFT section 106 from the error correcting code-ized section 103.
[0105] Consequently, in the IFFT section 106, it is in the state where only the transmit data of the 2nd sequence and the 3rd sequence was inputted, and the OFDM signal in the symbol which generated the peak power which exceeds a threshold in the peak-detection section 401 is generated. That is, the OFDM signal with which only the 2nd subcarrier and the 3rd subcarrier were overlapped on the transmit data of the 2nd sequence and the 3rd sequence, respectively is generated.
[0106] Here, any signals are not superimposed by the 1st subcarrier and the 4th subcarrier. If another word is carried out, an amplitude can tell the 1st subcarrier and the 4th subcarrier that it is superimposed on the signal of abbreviation

0. By this, the number of subcarriers with which it is superimposed on an information signal will decrease from four to two. Therefore, as for the OFDM signal in which regeneration was carried out by the IFFT section 106, a peak power becomes a repressed thing.

[0107] Detection of whether by the peak-detection section 401, as mentioned above, the peak power exceeding a threshold has generated the OFDM signal in which regeneration was carried out by the IFFT section 106 is made. When the peak power which exceeds a threshold to the OFDM signal by which regeneration was carried out has not occurred, this OFDM signal by which regeneration was carried out is sent to the D/A-conversion section 110. On the contrary, when the peak power which still exceeds a threshold to the OFDM signal by which regeneration was carried out has occurred, the OFDM signal which was mentioned above and which was memorized temporarily is sent to a clipping circuit 109. Then, this equipment shifts to a normal state from a peak suppression state.

[0108] The detail of a clipping circuit 109 and the D/A-conversion section 110 is the same as the gestalt 1 of operation. The OFDM signal after the modulation processing transmitted by the sending set equipped with the multi-carrier communication device concerning the gestalt of this operation is received through an antenna 113 by the receiving set shown in drawing 2 .

[0109] With reference to drawing 2 , as the gestalt 1 of operation explained in the FFT section 205, each signal transmitted by the 1st subcarrier - the 4th subcarrier is extracted by carrying out FFT processing of the recovery signal changed into the digital signal. That is, in the FFT section 205, the 1st recovery signal - 4th recovery signal is extracted.

[0110] the [of the 1st subcarrier and the 4th subcarrier / the 1st recovery signal which was alike, respectively and was transmitted more, and] -- 4 recovery signals become what contained the error in the OFDM signal in the symbol which the peak power exceeding a threshold generated the [for this reason, / the 1st recovery signal and] -- 4 recovery signals may turn into a signal containing the error with this

[0111] the [then, / the 1st recovery signal and] -- 4 recovery signals are sent to the error correction decode section 206 and the error correction decode section 207, respectively, and error correction decode processing is made thereby -- the [the 1st recovery signal and] -- a suitable signal corrects a portion [made / the mistake / in in 4 recovery signals]

[0112] Thus, when the peak power which exceeds a threshold to an OFDM signal generates the specific subcarrier of the predetermined number of this subcarrier, in the gestalt of this operation, the subcarrier which transmits only a peak suppression signal fixed, and the subcarrier which transmits only an information signal are not prepared, but only the subcarrier for information for transmitting an information signal is prepared, it stops, and the thing of the transmission of an information signal is carried out, and it is used.

[0113] Furthermore, in a normal state, it is superimposed on the signal with which error correcting code-ized processing was usually performed to the information signal of a low rate from the rate to the specific subcarrier, and is usually superimposed on the information signal of a rate to subcarriers for information other than a specific subcarrier. On the other hand, in a peak suppression state, a specific subcarrier is not overlapped on an information signal, but only the other subcarriers for information are overlapped on an information signal.

[0114] While being able to oppress the peak power in an OFDM signal certainly by not superimposing an information signal on a specific subcarrier in a peak suppression state according to such composition, in a normal state, decline in a transmission efficiency can be suppressed by superimposing an information signal on all subcarriers.

[0115] Furthermore, as for the information signal on which the signal transmitted by the specific subcarrier is superimposed by this specific carrier although an information signal will be contained at the time of peak suppression, error correcting code-ized processing is performed. Thereby, the signal transmitted by this specific subcarrier turns into a signal which corrected the mistaken portion (portion which is not superimposed on the information signal) by performing error correction decryption processing with receiving-side equipment. That is, the information signal on which a specific subcarrier is overlapped is received by receiving-side equipment in the good state.

[0116] As mentioned above, according to the gestalt of this operation, the multi-carrier communication device which oppresses a peak power can be offered, suppressing decline in a transmission efficiency.

[0117] In addition, in the gestalt of this operation, although the number of subcarriers to be used was explained taking the case of the case where it is referred to as 4, there is no limitation in the number of subcarriers to be used. Moreover, in the gestalt of this operation, although the number of the specific subcarriers which stop transmission of an information signal was explained taking the case of the case where it is referred to as two when the peak power which exceeds a threshold to an OFDM signal occurred, it is possible to change the number of specific subcarriers according to various conditions, such as peak-power suppression condition by the transmission stop of an information signal.

[0118] The gestalt of this operation does not prepare the subcarrier which transmits only a peak suppression signal fixed, and the subcarrier which transmits only an information signal. (Gestalt 3 of operation) After preparing all the subcarriers as a subcarrier which can transmit both a peak suppression signal and an information signal, to a normal

state While an information signal is superimposed on all subcarriers, a peak suppression signal is superimposed on the subcarrier chosen as the peak suppression state from all subcarriers.

[0119] The communication device hereafter equipped with the multi-carrier communication device concerning the gestalt of this operation is explained with reference to drawing 5 . Drawing 5 is the block diagram showing the composition of the sending set equipped with the multi-carrier communication device concerning the gestalt 3 of operation of this invention. In addition, about the same composition as the gestalt 1 (drawing 1) of the operation in drawing 5 , the same sign as the thing in drawing 1 is attached, and detailed explanation is omitted.

[0120] In drawing 5 , the S/P transducer 501 changes the transmit data of one sequence into the transmit data of two or more sequences (here, it considers as four sequences as an example) like the S/P transducer 101 in the gestalt 1 of operation. Here, the transmit data of the 1st sequence - the 4th sequence is called for convenience, applying [of two or more sequences shown in drawing 5] it to the lower part from the upper part. This S/P transducer 501 sends all the transmit data of the 1st sequence - the 4th sequence to a switch 504 - a switch 507 as transmit data of this rate, respectively.

[0121] Like the peak-detection section 107 in the gestalt 1 of operation, the peak-detection section 503 measures the power of the OFDM signal from the IFFT section 106 per symbol, and detects whether the peak power exceeding a threshold has occurred about the OFDM signal in each symbol.

[0122] This peak-detection section 503 sends the OFDM signal in the symbol which this peak power has not generated to the D/A-conversion section 110, when the peak power which exceeds a threshold to an OFDM signal does not occur.

[0123] moreover, when the peak power which exceeds a threshold to an OFDM signal occurs, this peak-detection section 503 The OFDM signal in the symbol which generated this peak power is memorized temporarily. The purport which the peak power exceeding a threshold generated is notified to the compensation carrier determination section 502. The IFFT section 106 is controlled to perform regeneration of the OFDM signal in the symbol which generated the peak power exceeding a threshold, and the peak suppression signal generator 108 is controlled to generate a peak suppression signal.

[0124] Furthermore, this peak-detection section 503 controls the IFFT section 106 to continue regeneration of the OFDM signal in the symbol which generated the peak power while generating a peak suppression signal to the peak suppression signal generator 108 until the number of the 2nd repeats reaches the number of conventions when the peak power which still exceeds a threshold also to the OFDM signal in which regeneration was carried out by the IFFT section 106 has occurred. The peak-detection section 503 sends the OFDM signal in the symbol concerned held temporarily to a clipping circuit 109, when the number of the 2nd repeats reaches the number of conventions at this time.

[0125] The compensation carrier determination section 502 performs change control to a switch 504 - a switch 507 according to whether the peak power which exceeds a threshold to the OFDM signal generated by the IFFT section 106 occurred corresponding to the content of a notice from the peak-detection section 503.

[0126] Drawing 6 is the block diagram showing the composition of the sending set equipped with the multi-carrier communication device concerning the gestalt 3 of operation of this invention, and the receiving set which performs radio. In addition, about the same composition as the gestalt 1 (drawing 2) of the operation in drawing 6 , the same sign as the thing in drawing 2 is attached, and detailed explanation is omitted. Unlike the gestalt 1 of operation, in drawing 6 , the 1st recovery signal extracted by the FFT section 205 - the 4th recovery signal are sent to the P/S transducer 208, without carrying out error correction decode processing altogether.

[0127] Subsequently, operation of the sending set equipped with the multi-carrier communication device concerning the gestalt of this operation is again explained with reference to drawing 5 . When this equipment is in a normal state, a switch 504 - a switch 507 are controlled by the compensation carrier determination section 502 to output the transmit data of the 1st sequence from the S/P transducer 501 - the 4th sequence to the IFFT section 106.

[0128] In the IFFT section 106, IFFT processing (namely, Frequency-Division-Multiplexing processing) using the transmit data of the 1st sequence - the 4th sequence is performed. The OFDM signal with which the 1st subcarrier - the 4th subcarrier were overlapped on the transmit data of the 1st sequence - the 4th sequence, respectively is generated by this Frequency-Division-Multiplexing processing. The generated OFDM signal is sent to the peak-detection section 503.

[0129] In the peak-detection section 503, it is detected whether the peak power to which the power of the OFDM signal from the IFFT section 106 is measured per symbol, and exceeds a threshold to the OFDM signal in each symbol has occurred.

[0130] When the peak power which exceeds a threshold from the IFFT section 106 to an OFDM signal has not occurred, the OFDM signal in the symbol which this peak power has not generated is sent to the D/A-conversion

section 110.
[0131] On the contrary, when the peak power which exceeds a threshold from the IFFT section 106 to an OFDM signal occurs, while the OFDM signal in the symbol which generated this peak power is memorized temporarily, this equipment shifts to a peak suppression state from a normal state.
[0132] The following processings are made when this equipment shifts to a peak suppression state. That is, the control signal of the purport which performs regeneration of the OFDM signal in the symbol which generated the peak power which exceeds a threshold from the peak-detection section 503 to the IFFT section 106 is sent, and the control signal of the purport which generates a peak suppression signal from the peak-detection section 503 to the peak suppression signal generator 108 is sent.
[0133] In the peak suppression signal generator 108 which received the above-mentioned control signal, the output of the peak suppression signal over a switch 504 - a switch 507 is performed. In addition, about a peak suppression signal here, since it is the same as that of the thing in the gestalt 1 of operation, detailed explanation is omitted.
[0134] Furthermore, the purport which the peak power which exceeds a threshold to the OFDM signal generated by the IFFT section 106 from the peak-detection section 503 to the compensation carrier determination section 502 has generated is notified.
[0135] It is controlled so that either the switch 504 or - the switches 507 (switch 504 as [Here] an example) replace with the transmit data of the 1st sequence and it outputs the peak suppression signal from the peak suppression signal generator 108 to the IFFT section 106 by the compensation carrier determination section 502 which received this notice.
[0136] Then, in the IFFT section 106, regeneration of the OFDM signal in the symbol which generated the peak power which exceeds a threshold in the peak-detection section 503 is carried out. That is, the OFDM signal with which the 1st subcarrier was overlapped on the peak suppression signal, and the 2nd subcarrier - the 4th subcarrier were overlapped on the transmit data of the 2nd sequence - the 4th sequence, respectively is generated. About the effect by the peak suppression signal in an IFFT operation, since it is the same as that of the gestalt 1 of operation, detailed explanation is omitted.
[0137] Detection of whether by the peak-detection section 503, as mentioned above, the peak power exceeding a threshold has generated the OFDM signal in which regeneration was carried out by the IFFT section 106 is made. When the peak power which exceeds a threshold to the OFDM signal by which regeneration was carried out has not occurred, this OFDM signal by which regeneration was carried out is sent to the D/A-conversion section 110.
[0138] On the contrary, when the peak power which still exceeds a threshold to the OFDM signal by which regeneration was carried out has occurred, the control signal of the purport which performs regeneration of the OFDM signal in the above-mentioned symbol from the peak-detection section 503 to the IFFT section 106 is sent again, and the control signal of the purport which outputs a peak suppression signal to a switch 507 is again sent from a switch 504 from the peak-detection section 503 to the peak suppression signal generator 108. At this time, the number of the 1st repeats about the regeneration of an OFDM signal is increased in the peak-detection section 503.
[0139] In the peak suppression signal generator 108 which received this control signal, generating of a peak suppression signal to a switch 507 is again performed from a switch 504. However, a suitable signal other than the suitable signal mentioned above as a peak suppression signal again is generated at this time.
[0140] Consequently, in the IFFT section 106, the 1st subcarrier is overlapped on a new peak suppression signal, regeneration of the OFDM signal in the symbol which generated the peak power which exceeds a threshold in the peak-detection section 503 is carried out, and as the OFDM signal by which regeneration was carried out was mentioned above, detection of whether the peak power exceeding a threshold has occurred by the peak-detection section 503 is made.
[0141] Henceforth, while a peak suppression signal is updated by another, suitable signal until the peak power which exceeds a threshold to the OFDM signal by which regeneration was carried out stops occurring, the regeneration of the OFDM signal in the same symbol which was mentioned above is repeated. However, when the number of the 1st repeats reaches the number of conventions, the control signal of the purport which performs regeneration of the OFDM signal in the above-mentioned symbol from the peak-detection section 503 to the IFFT section 106 is sent again, and the purport which the peak power which exceeds a threshold to the OFDM signal generated by the IFFT section 106 from the peak-detection section 503 to the compensation carrier determination section 502 has generated is notified again. While the number of the 2nd repeats about the regeneration of an OFDM signal is increased in the peak-detection section 503 at this time, the number of the 1st repeats is reset.
[0142] It is controlled so that either the switch 505 except a switch 504 or - the switches 507 (switch 505 as [Here] an example) replace with the transmit data of the 2nd sequence and it outputs the peak suppression signal from the peak suppression signal generator 108 to the IFFT section 106 shortly by the compensation carrier determination section 502

which received this notice.

[0143] Then, while regeneration of an OFDM signal which was mentioned above by the IFFT section 106 is performed, as the OFDM signal by which regeneration was carried out was mentioned above in the peak-detection section 503, detection of whether the peak power exceeding a threshold has occurred is made.

[0144] Henceforth, while a peak suppression signal is updated by another, suitable signal until the peak power which exceeds a threshold to the OFDM signal by which regeneration was carried out stops occurring, the regeneration of the OFDM signal in the same symbol which was mentioned above is repeated. However, when the number of the 1st repeats reaches the number of conventions, the control signal of the purport which performs regeneration of the OFDM signal in the above-mentioned symbol from the peak-detection section 503 to the IFFT section 106 is sent again, and the purport which the peak power which exceeds a threshold to the OFDM signal generated by the IFFT section 106 from the peak-detection section 503 to the compensation carrier determination section 502 has generated is notified again. While the number of the 2nd repeats about the regeneration of an OFDM signal is increased in the peak-detection section 503 at this time, the number of the 1st repeats is reset.

[0145] Then, while the switch which replaces with an information signal and outputs a peak suppression signal is switched until the peak power which exceeds a threshold to the OFDM signal by which regeneration was carried out stops occurring, the regeneration of the OFDM signal in the same symbol which was mentioned above is repeated. However, when the above-mentioned number of the 2nd repeats reaches the number of conventions, the OFDM signal temporarily memorized by the peak-detection section 503 is sent to a clipping circuit 109. Then, this equipment shifts to a normal state from a peak suppression state.

[0146] The OFDM signal after the modulation processing transmitted by the sending set equipped with the multi-carrier communication device concerning the gestalt of this operation is received through an antenna 113 by the receiving set shown in drawing 6 .

[0147] With reference to drawing 6 , as the gestalt 1 of operation explained in the FFT section 205, each signal transmitted by the 1st subcarrier - the 4th subcarrier is extracted by carrying out FFT processing of the recovery signal changed into the digital signal. That is, in the FFT section 205, the 1st recovery signal - 4th recovery signal is extracted.

[0148] In the 1st recovery signal which the 1st subcarrier - the 4th subcarrier were alike, respectively, and was transmitted more - the 4th recovery signal, what was included having made the mistake in setting as the symbol which the peak power which exceeds a threshold to an OFDM signal generated (peak suppression signal) may exist. However, when some errors are permitted, the these 1st recovery signal - 4th recovery signal serves as reproducible decode data by making error correction decryption processing, after being changed into the signal of one sequence by the P/S transducer 208 (for example, when the transmit data inputted into the S/P transducer 501 in the sending set shown in drawing 5 is already error-correcting-code-ized etc.).

[0149] Thus, in the gestalt of this operation, the subcarrier which transmits only a peak suppression signal fixed, and the subcarrier which transmits only an information signal were not prepared, but all subcarriers are prepared as a subcarrier which can transmit both a peak suppression signal and an information signal.

[0150] Furthermore, in a normal state, while all subcarriers are overlapped on an information signal, in a peak suppression state, one of subcarriers is overlapped on a peak suppression signal, and subcarriers other than this are overlapped on an information signal.

[0151] While being able to oppress the peak power in an OFDM signal certainly by superimposing a peak suppression signal on one of subcarriers in a peak suppression state according to such composition, in a normal state, decline in a transmission efficiency can be suppressed by superimposing an information signal on all subcarriers.

[0152] In addition, in the gestalt of this operation, although the number of subcarriers to be used was explained taking the case of the case where it is referred to as 4, there is no limitation in the number of subcarriers to be used. Moreover, in the gestalt of this operation, although the number of the subcarriers which superimpose a peak suppression signal at the time of the regeneration of an OFDM signal was explained taking the case of the case where it is referred to as one, it is also possible to set or more to two the number of subcarriers which superimposes a peak suppression signal. In this case, the peak power in an OFDM signal can be oppressed further.

[0153] Moreover, although the OFDM signal with which the subcarrier which superimposes a peak suppression signal is chosen one by one, and the peak power became below the threshold was explained in the gestalt of this operation taking the case of the case where it sends to the D/A-conversion section 110, at the time of the regeneration of an OFDM signal this invention is not limited to this, but memorizes the OFDM signal by which regeneration was carried out by superimposing a peak suppression signal on all subcarriers, and you may make it send an OFDM signal with the smallest peak power to the D/A-conversion section 110 among the memorized OFDM signals. Thereby, since the peak power of an OFDM signal can be oppressed as much as possible, influence of the linear strain kicked to power

amplifier can be made small.

[0154] (Gestalt 4 of operation) After preparing all the subcarriers as a subcarrier which transmits only an information signal rather than preparing the subcarrier which transmits only a peak suppression signal fixed, and the subcarrier which transmits only an information signal, while the gestalt of this operation superimposes an information signal on all subcarriers, it stops transmission of the information signal by the subcarrier chosen from all subcarriers in the peak suppression state at a normal state.

[0155] The communication device hereafter equipped with the multi-carrier communication device concerning the gestalt of this operation is explained with reference to drawing 7 . Drawing 7 is the block diagram showing the composition of the sending set equipped with the multi-carrier communication device concerning the gestalt 4 of operation of this invention. In addition, about the same composition as the gestalt 1 (drawing 1) of the operation in drawing 7 , the same sign as the thing in drawing 1 is attached, and detailed explanation is omitted.

[0156] In drawing 7 , like the peak-detection section 107 in the gestalt 1 of operation, the peak-detection section 702 measures the power of the OFDM signal from the IFFT section 106 per symbol, and detects whether the peak power exceeding a threshold has occurred about the OFDM signal in each symbol.

[0157] This peak-detection section 702 sends the OFDM signal in the symbol which this peak power has not generated to the D/A-conversion section 110, when the peak power which exceeds a threshold to an OFDM signal does not occur.

[0158] Moreover, this peak-detection section 702 memorizes temporarily the OFDM signal in the symbol which generated this peak power when the peak power which exceeds a threshold to an OFDM signal occurred, notifies the purport which the peak power exceeding a threshold generated to the non-transmitted carrier determination section 701, and controls the IFFT section 106 to perform regeneration of the OFDM signal in the symbol which generated the peak power exceeding a threshold.

[0159] Furthermore, this peak-detection section 702 controls the IFFT section 106 to continue regeneration of the OFDM signal in the symbol which generated the peak power while notifying the purport which the peak power which exceeds a threshold to the non-transmitted carrier determination section 701 generated until the number of the 1st repeats reaches the number of conventions when the peak power which still exceeds a threshold also to the OFDM signal in which regeneration was carried out by the IFFT section 106 has occurred. The peak-detection section 702 sends the OFDM signal in the symbol concerned memorized temporarily to a clipping circuit 109, when the number of the 1st repeats reaches the number of conventions at this time.

[0160] The non-transmitted carrier determination section 701 performs change control to a switch 504 - a switch 507 according to whether the peak power which exceeds a threshold to the OFDM signal generated by the IFFT section 106 occurred corresponding to the content of a notice from the peak-detection section 702.

[0161] About the composition of the sending set equipped with the multi-carrier communication device concerning the gestalt of this operation on the other hand, and the receiving set which performs radio, since it is the same as that of what was explained with the gestalt 3 (drawing 6) of operation, detailed explanation is omitted.

[0162] Subsequently, operation of the sending set equipped with the multi-carrier communication device concerning the gestalt of this operation is again explained with reference to drawing 7 . About operation in case this equipment is in a normal state, it is the same as that of the gestalt 3 of operation except for the point controlled by the non-transmitted carrier determination section 701 so that a switch 504 - a switch 507 output the transmit data of the 1st sequence from the S/P transducer 501 - the 4th sequence to the IFFT section 106.

[0163] The following processings are made when this equipment shifts to a peak suppression state from a normal state. That is, the control signal of the purport which performs regeneration of the OFDM signal in the symbol which generated the peak power which exceeds a threshold from the peak-detection section 702 to the IFFT section 106 is sent, and the purport which the peak power which exceeds a threshold to the OFDM signal generated by the IFFT section 106 from the peak-detection section 702 to the non-transmitted carrier determination section 701 has generated is notified.

[0164] Either the switch 504 or - the switches 507 (switch 504 as [Here] an example) are controlled by the non-transmitted carrier determination section 701 which received this notice to suspend the output to the IFFT section 106 of the transmit data of the 1st sequence.

[0165] Then, in the IFFT section 106, regeneration of the OFDM signal in the symbol which generated the peak power which exceeds a threshold in the peak-detection section 702 is carried out. That is, the OFDM signal with which the 2nd subcarrier - the 4th subcarrier were overlapped on the transmit data of the 2nd sequence - the 4th sequence, respectively is generated. Here, any signals are not superimposed by the 1st subcarrier. If another word is carried out, an amplitude can tell the 1st subcarrier that it is superimposed on the signal of abbreviation 0.

[0166] Detection of whether the peak power exceeding a threshold has generated the OFDM signal in which

regeneration was carried out by the IFFT section 106 like the gestalt 1 of operation by the peak-detection section 702 is made. When the peak power which exceeds a threshold to the OFDM signal by which regeneration was carried out has not occurred, this OFDM signal by which regeneration was carried out is sent to the D/A-conversion section 110. On the contrary, when the peak power which still exceeds a threshold to the OFDM signal by which regeneration was carried out has occurred, the control signal of the purport which performs regeneration of the OFDM signal in the above-mentioned symbol from the peak-detection section 702 to the IFFT section 106 is sent again, and the purport which the peak power which exceeds a threshold to the OFDM signal generated by the IFFT section 106 from the peak-detection section 702 to the non-transmitted carrier determination section 701 has generated is notified again. At this time, the number of the 1st repeats about the regeneration of an OFDM signal is increased in the peak-detection section 702.

[0167] Either the switch 505 except a switch 504 or - the switches 507 (switch 505 as [Here] an example) are shortly controlled by the non-transmitted carrier determination section 701 which received this notice to suspend the output to the IFFT section 106 of the transmit data of the 2nd sequence.

[0168] Then, while regeneration of an OFDM signal which was mentioned above by the IFFT section 106 is performed, as the OFDM signal by which regeneration was carried out was mentioned above in the peak-detection section 702, detection of whether the peak power exceeding a threshold has occurred is made.

[0169] Henceforth, while the switch which suspends the output of the information signal to the IFFT section 106 is switched until the peak power which exceeds a threshold to the OFDM signal by which regeneration was carried out stops occurring, the regeneration of the OFDM signal in the same symbol which was mentioned above is repeated. However, when the above-mentioned number of the 1st repeats reaches the number of conventions, the OFDM signal temporarily memorized by the peak-detection section 702 is sent to a clipping circuit 109. Then, this equipment shifts to a normal state from a peak suppression state.

[0170] The OFDM signal after the modulation processing transmitted by the sending set equipped with the multi-carrier communication device concerning the gestalt of this operation is received through an antenna 113 by the receiving set shown in drawing 6 .

[0171] With reference to drawing 6 , as the gestalt 1 of operation explained in the FFT section 205, each signal transmitted by the 1st subcarrier - the 4th subcarrier is extracted by carrying out FFT processing of the recovery signal changed into the digital signal. That is, in the FFT section 205, the 1st recovery signal - 4th recovery signal is extracted.

[0172] In the 1st recovery signal which the 1st subcarrier - the 4th subcarrier were alike, respectively, and was transmitted more - the 4th recovery signal, what does not contain an information signal in an OFDM signal in the symbol which the peak power exceeding a threshold generated may exist. However, when some errors are permitted, the these 1st recovery signal - 4th recovery signal serves as reproducible decode data by making error correction decryption processing, after being changed into the signal of one sequence by the P/S transducer 208 (for example, when the transmit data inputted into the S/P transducer 501 in the sending set shown in drawing 7 is already error-correcting-code-ized etc.).

[0173] Thus, in the gestalt of this operation, the subcarrier which transmits only a peak suppression signal fixed, and the subcarrier which transmits only an information signal were not prepared, but all subcarriers are prepared as a subcarrier which transmits only an information signal's.

[0174] Furthermore, in a normal state, while an information signal is superimposed on all subcarriers, in a peak suppression state, transmission of the information signal by the subcarrier chosen from all subcarriers is stopped.

[0175] While being able to oppress the peak power in an OFDM signal certainly by stopping transmission of the information signal by one of subcarriers in a peak suppression state according to such composition, in a normal state, decline in a transmission efficiency can be suppressed by superimposing an information signal on all subcarriers.

[0176] In addition, in the gestalt of this operation, although the number of subcarriers to be used was explained taking the case of the case where it is referred to as 4, there is no limitation in the number of subcarriers to be used. Moreover, in the gestalt of this operation, although the number of the subcarriers which do not superimpose an information signal at the time of the regeneration of an OFDM signal was explained taking the case of the case where it is referred to as one, it is also possible to set or more to two the number of subcarriers which does not superimpose an information signal. In this case, the peak power in an OFDM signal can be oppressed further.

[0177] Moreover, although the OFDM signal with which the subcarrier which stops transmission of an information signal is chosen one by one, and the peak power became below the threshold was explained in the gestalt of this operation taking the case of the case where it sends to the D/A-conversion section 110, at the time of the regeneration of an OFDM signal this invention is not limited to this, but when transmission of the information signal of each subcarrier is stopped, it memorizes the OFDM signal by which regeneration was carried out, and you may make it send

an OFDM signal with the smallest peak power to the D/A-conversion section 110 among the memorized OFDM signals. Thereby, since the peak power of an OFDM signal can be oppressed as much as possible, influence of the linear strain kicked to power amplifier can be made small.

[0178] Moreover, in the gestalten 1-4 of the above-mentioned implementation, when the peak power had still occurred also by the regeneration of an OFDM signal, clipping processing was carried out by the clipping circuit 109, and not the OFDM signal in the symbol concerned by which regeneration was carried out but the OFDM signal (namely, OFDM signal generated first) in the symbol concerned memorized by the peak-detection section was explained taking the case of the case where it sends to the D/A-conversion section 110. The OFDM signal in the symbol concerned memorized by the peak-detection section to this being the signal with which this invention persons were superimposed on the OFDM signal by which regeneration was carried out by the subcarrier predetermined [signal / of abbreviation 0] in a peak suppression signal or an amplitude, and were generated is because it notes being the signal with which a peak suppression signal and an amplitude were generated, without being superimposed on the signal of abbreviation 0 etc. That is, the direction of the signal which carried out clipping processing of the OFDM signal generated first rather than the signal with which this invention persons did clipping processing of the OFDM signal by which regeneration was carried out notes that quality is good. Thereby, the quality of the input signal by the side of a receiving set will become good.

[0179] Moreover, it sets in the gestalt 1 of the above-mentioned implementation, and the gestalt 2 of operation. Although the transmit data by which error correcting code-ization is made among the transmit data of each sequence outputted by the S/P transducer 101 was explained taking the case of the case where it considers as a low rate in order to unify the rate of the transmit data of each sequence inputted into the IFFT section 106 When the method (for example, trellis coding modulation technique) which does not change the rate of the transmit data after error-correcting-code-izing is used as an error correcting code-ized method, let all the rates of the transmit data of each sequence outputted by the S/P transducer 101 be standard rates.

[0180] Furthermore, the sending set equipped with the multi-carrier communication device explained with the gestalten 1-4 of the above-mentioned implementation and this sending set, and the receiving set that performs radio can be carried in the communication terminal and base station equipment in digital mobile communication system.

[0181]

[Effect of the Invention] As explained above, when a peak power does not occur to a multi-carrier signal according to this invention When an information signal is superimposed to all subcarriers and a peak power occurs to a multi-carrier signal The multi-carrier communication device which oppresses a peak power can be offered suppressing decline in a transmission efficiency, since the signal for replacing with an information signal and oppressing a peak power to the specific subcarrier of all the subcarriers was superimposed.

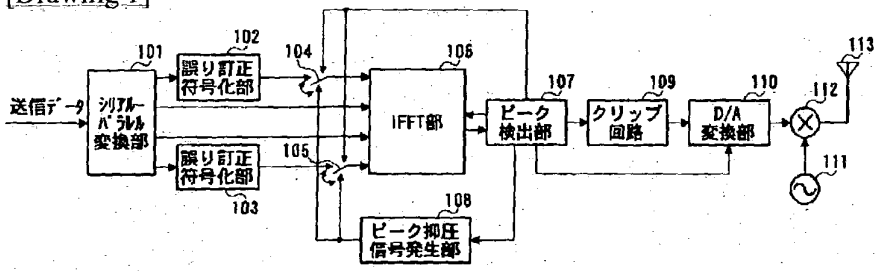
[Translation done.]

* NOTICES *

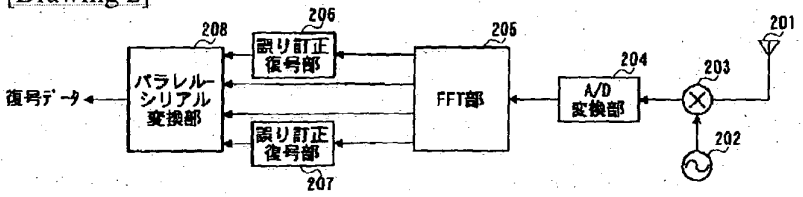
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

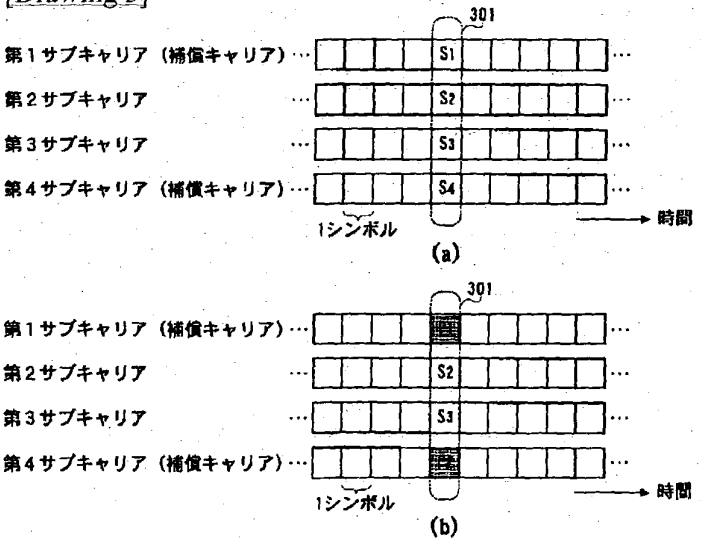
[Drawing 1]



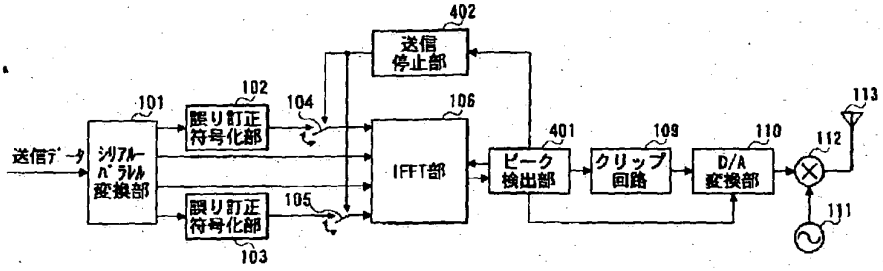
[Drawing 2]



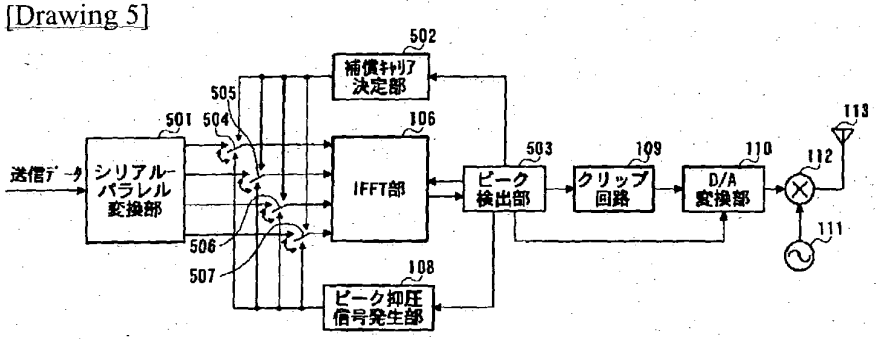
[Drawing 3]



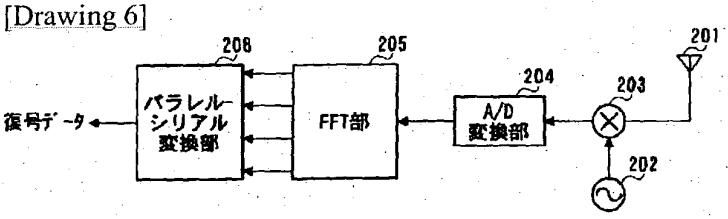
[Drawing 4]



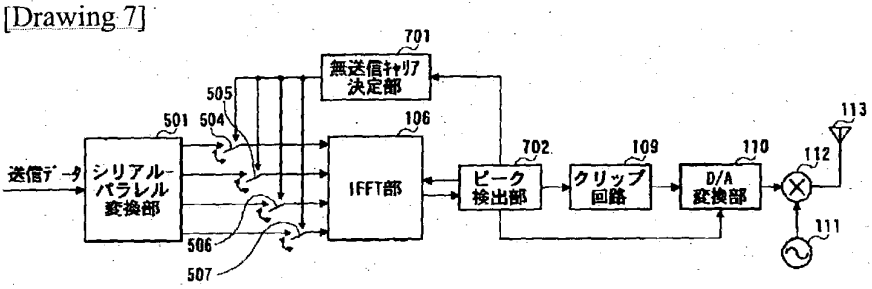
[Drawing 5]



[Drawing 6]



[Drawing 7]



[Translation done.]